WHAT IS CLAIMED IS:

1. An optimum design method comprising:

a first solution determining step of solving an optimization problem of a first evaluation function for a state variable vector with a design variable vector being as a parameter; and

a second solution determining step of solving an optimization problem of a second evaluation function for the design variable vector and the state variable vector obtained in the first solution determining step,

wherein the second solution determining step includes:

a gradient vector computing step of computing a gradient vector of the second evaluation function for the design variable vector;

a first coefficient computing step of computing a first coefficient based on a value of a norm of the gradient vector;

a search vector computing step of computing a search vector based on the first coefficient;

a second coefficient computing step of computing a second coefficient; and

a design variable vector updating step of updating the design variable vector based on the second coefficient,

the second coefficient computing step including the

first solution determining step, the first solution determining step being executed as an iterative method based on the gradient vector, and the state variable vector being not initialized during iteration.

2. An optimum design method according to Claim 1, wherein the line search step comprises:

a maximum step size computing step of deciding a maximum step size in accordance with a restraint condition;

a search range narrowing step of deciding a minimum point from a search range decided by the maximum step size; and

a minimum point deciding step of deciding a minimum point in accordance with a comparison between a value of the second evaluation function at the minimum point and a value of the second evaluation function at an end point of the search range.

3. An optimum design method according to Claim 1, wherein the second solution determining step includes an erasing step of erasing, from the design variable vector, a component corresponding to a structural element that does not contributes to the second evaluation function.

4. An optimum design method according to Claim 1,

wherein the erasing step erases a component for which a value of sensitivity of the second evaluation function for the design variable vector is always 0 when a value of each component of the design variable vector is increased and decreased.

5. An optimum design method according to Claim 1, wherein the erasing step is executed on an element corresponding to a component for which a sensitivity vector computed in the second solution determining step is 0, the element providing existence probability of a structural element other than 0.

6. An optimum design method according to Claim 1, wherein the erasing step is executed once per predetermined number of times of iteration processes in the second solution determining step.

7. An optimum design method according to Claim 1, wherein the design variable vector is existence probability of a structural element in each element.

8. An optimum design method according to Claim 1, further comprising a gradient vector correcting step of correcting the gradient vector computed in the gradient

vector computing step in accordance with a restraint condition.

9. An optimum design method according to Claim 1, further comprising a search vector correcting step of correcting the search vector computed in the search vector computing step in accordance with a restraint condition.

10. An optimum design method according to Claim 1, further comprising a design variable vector correcting step of correcting the design variable vector computed in the design variable vector computing step in accordance with a restraint condition.

11. An optimum design method according to Claim 1, further comprising a convergence determining step of determining based on the value of the norm of the gradient vector whether the second solution determining step is brought to an end.

12. An optimum design apparatus comprising:

first solution determining means for solving an optimization problem of a first evaluation function for a state variable vector with a design variable vector being as a parameter; and

second solution determining means for solving an optimization problem of a second evaluation function for the design variable vector and the state variable vector obtained in the first solution determining means,

wherein the second solution determining means includes:

gradient vector computing means for computing a gradient vector of the second evaluation function for the design variable vector;

first coefficient computing means for computing a first coefficient based on a value of a norm of the gradient vector;

search vector computing means for computing a search vector based on the first coefficient;

second coefficient computing means for computing a second coefficient; and

design variable vector updating means for updating the design variable vector based on the second coefficient,

the second coefficient computing means including the first solution determining means, the first solution determining means being executed as an iterative method based on the gradient vector, and the state variable vector being not initialized during iteration.

13. A computer-readable optimum design program, the program comprising codes for causing a computer to perform

an optimum design method comprising:

a first solution determining step of solving an optimization problem of a first evaluation function for a state variable vector with a design variable vector being as a parameter; and

a second solution determining step of solving an optimization problem of a second evaluation function for the design variable vector and the state variable vector obtained in the first solution determining step,

wherein the second solution determining step includes:

a gradient vector computing step of computing a gradient vector of the second evaluation function for the design variable vector;

a first coefficient computing step of computing a first coefficient based on a value of a norm of the gradient vector;

a search vector computing step of computing a search vector based on the first coefficient;

a second coefficient computing step of computing a second coefficient; and

a design variable vector updating step of updating the design variable vector based on the second coefficient,

the second coefficient computing step including the first solution determining step, the first solution determining step being executed as an iterative method based

on the gradient vector, and the state variable vector being not initialized during iteration.

14. An optimum design method comprising:

a first solution determining step of solving an optimization problem of a first evaluation function for a state variable vector with a design variable vector being as a parameter; and

a second solution determining step of solving an optimization problem of a second evaluation function for the design variable vector and the state variable vector obtained in the first solution determining step,

wherein the second solution determining step includes a design variable vector updating step of updating the design variable vector in sequence, the design variable vector updating step including:

a minimum point searching step of making search from a start point to obtain a minimum point; and

a terminal point evaluating step of deciding an optimum point based on a value of the second evaluation function at the minimum point and a value of the second evaluation function at an end point.

15. An optimum design method according to Claim 14, wherein the minimum point searching step employs a zone

reduction method utilizing the golden section.

16. An optimum design method according to Claim 14, wherein the minimum point searching step employs an estimation method based on approximation with a curve of secondary degree.

17. An optimum design apparatus comprising:

first solution determining means for solving an optimization problem of a first evaluation function for a state variable vector with a design variable vector being as a parameter; and

second solution determining means for solving an optimization problem of a second evaluation function for the design variable vector and the state variable vector obtained in the first solution determining means,

wherein the second solution determining means includes design variable vector updating means for updating the design variable vector in sequence, the design variable vector updating means including:

minimum point searching means for making search from a start point to obtain a minimum point; and

terminal point evaluating means for deciding an optimum point based on a value of the second evaluation function at the minimum point and a value of the second evaluation

function at an end point.

18. A computer-readable optimum design program, the program comprising codes for causing a computer to perform an optimum design method comprising:

a first solution determining step of solving an optimization problem of a first evaluation function for a state variable vector with a design variable vector being as a parameter; and

a second solution determining step of solving an optimization problem of a second evaluation function for the design variable vector and the state variable vector obtained in the first solution determining step,

wherein the second solution determining step includes a design variable vector updating step of updating the design variable vector in sequence, the design variable vector updating step including:

a minimum point searching step of making search from a start point to obtain a minimum point; and

a terminal point evaluating step of deciding an optimum point based on a value of the second evaluation function at the minimum point and a value of the second evaluation function at an end point.

19. An optimum design method comprising:

a first solution determining step of solving an optimization problem of a first evaluation function for a state variable vector with a design variable vector being as a parameter;

a second solution determining step of solving an optimization problem of a second evaluation function for the design variable vector and the state variable vector obtained in the first solution determining step; and

an erasing step of erasing, from the design variable vector, a component corresponding to a structural element that does not contributes to the second evaluation function.

20. An optimum design method according to Claim 19, wherein the design variable vector is existence probability of a structural element in each element.

21. An optimum design method according to Claim 19, wherein the erasing step erases a component for which an absolute value of sensitivity of the second evaluation function for the design variable vector is smaller than a preset value when a value of each component of the design variable vector is increased and decreased.

22. An optimum design method according to Claim 19, wherein the erasing step is executed on an element

corresponding to a component for which a sensitivity vector computed in the second solution determining step is 0, the element providing existence probability of a structural element other than 0.

23. An optimum design method according to Claim 19, wherein the erasing step is executed once per predetermined number of times of iteration processes in the second solution determining step.

24. An optimum design apparatus comprising:

first solution determining means for solving an optimization problem of a first evaluation function for a state variable vector with a design variable vector being as a parameter;

second solution determining means for solving an optimization problem of a second evaluation function for the design variable vector and the state variable vector obtained in the first solution determining means; and

erasing means for erasing, from the design variable vector, a component corresponding to a structural element that does not contributes to the second evaluation function.

25. A computer-readable optimum design program, the program comprising codes for causing a computer to perform

an optimum design method comprising:

a first solution determining step of solving an optimization problem of a first evaluation function for a state variable vector with a design variable vector being as a parameter;

a second solution determining step of solving an optimization problem of a second evaluation function for the design variable vector and the state variable vector obtained in the first solution determining step; and

an erasing step of erasing, from the design variable vector, a component corresponding to a structural element that does not contributes to the second evaluation function.